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# MOVEMENTS OF PHYTOPHAGOUS INSECT POPULATIONS BETWEEN UNGRAZED SANDY GRASSLAND AND ADJACENT AREAS

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## Abstract

Movement behaviour of *Auchenorrhyncha* and *Acridoidea* populations was studied in the boundary zones of ungrazed grassland patches and their surroundings on a sandy pasture field, at 0—50 cm height. The probability of the direction of movements was estimated by maximum likelihood method and chi square test.

Movements of 17 *Auchenorrhyncha* species (15%) were more or less directed. The ungrazed grassland supplied species for grazed areas mainly in the spring season, while in the dry summer period its „refuge" character became important as it was established from the increas of immigration from the pasture.

More marked directionality was observed in the movements of dominant grasshopper populations. The *Acridoidea* community of ungrazed area was continuously, intensively supplied from the pasture, and this tendency culminated in the summer. The movements were less intense in the boundary zone of the forest, and this means the retaining, attractive effect of the ungrazed patch.
*Key words: Acridoidea, Auchenorrhyncha,* direction, movement, sandy grassland, window-trap

## Introduction

Composition and spatio-temporal patterns of ecological communities at a habitat are influenced by the interactions with exterior communities. The intensity of these interactions depends on the similarity or dissimilarity of communities, on the degree of their isolation, on the size of the habitat, etc. In case of insect populations the most common manifestation of this relationship is in movement activities. Understandable, that the investigations of different movement types are frequent.

One of the extreme cases of asimmetric migrational relationships between communities of adjacent habitats is, when either fauna needs continuous supply (DELETTRE, 1986). There are partly similar seasonal migration relationships between the fauna of cultivated plants and that of connected bordering of weed (BEIRNE, 1956; ITO and MIYASHITA, 1961; ARZONE and VIDANO, 1984; etc.). In contradiction to these temporal habitats, the relationships of populations of continuously connected communities are more complicated, because in this case the possibility of continuous scattering exists (PURCELL and FRAZIER, 1985). The scattering individuals may utilize the surrounding patches as reservior (BLOCKER et al., 1972), wintering or feeding sites (WALOFF, 1973), or to complete their life cycles

(TAYLOR, 1985). The survival strategies coupled with migration or dispersion are well known (SYMMONS and MCCULLOCH, 1980; ROFF, 1975; ROBERTS, 1978; MARINO, 1986, etc.).

If we want to study the turnover of individuals of two contiguous habitats, it seems obvious that we would measure the movement of insects in the boundary zone. We can choose the layer of active flight (boundary layer), where the flight speed of insects is larger than the wind speed (TAYLOR, 1974). Over this the individuals that passed the „boundary layer interface" spread inactively. This movement is considered as the true migration (TERAGUCHI, 1986). Height of the boundary layer interface between active and passive spreed is changing from 30 cm to several meters in certain insect groups (TAYLOR, 1974). On the basis of literature, in our opinion the examination of active flight's zone indicates more precisely the flyings in from short distances (since the efficiency of gathering depends considerably on the distance from the trap (RAATIKAINEN and VASARAINEN, 1973), and this helps to eliminate the effect of wind near the soil surface (MEDLER, 1962).

The aim of this study is to investigate the movements in two insect communities in the boundary layer between an ungrazed grassland patch and the connecting pasture and forest, respectively. We want to draw a conclusion about, what is the degree of independence of the two communities with different indication of spatial heterogeneity (coarse grained or fine grained (GALLÉ et al., 1985), at habitats connected through boundary zones, and to what extent is similar or dissimilar the degree and direction of the seasonal individual turnover of their populations?

## Materials and methods

THE EXAMINED AREA

Investigations were carried out in the Bugac region of KNP at the 2.4 ha part of a sandy pasture that is free of grazing from 1976. At the southern, longer side this plot is adjacent to the wide pasture, that has been still used. At the opposite, northeastern side a 2—3 m broad earth road and a young aspen forest are situated. The surrounded area is heteromorphous because of the varied relief with sand hills and wind grooves, and on the other hand of mosaic-like pattern of vegetation that represent different successional stages. Three associations of varied patch size dominate the experimental area: 1. *Potentillo-Festucetum pseudovinae*; 2. *Festucetum vaginatae danubiale*; and 3. *Molinio-Salicetum rosmarinifoliae*. For detailed description of vegetation see KÖRMÖCZI et al., 1981; BODROGKÖZY and FARKAS, 1981.

COLLECTING METHODS

10—10 window traps were placed along the two longer sides of the experimental area (Fig. 1.). The size of collecting dishes was 50x25x5 cm, filled with ethyleneglycol as destroying agent. 2—2 dishes were divided by glass plate which was 50 cm high. The traps were placed parallel with the border line of the area to separate the entering and leaving individuals. Traps worked from March to November each year, samples were collected in general fortnightly. In 1981 the samples were collected at heights of 0—50, 50—100 and 100—150 cm to determine the correlation between efficiency of collecting and height. In 1982 the two lower levels were used, and on the basis of their results in 1983 we evaluated only the material of the lowermost dishes. In 1982 we placed a trap with 6 dishes in the forest, 10 m from the edge of aspen woods, to estimate the populations moving there.

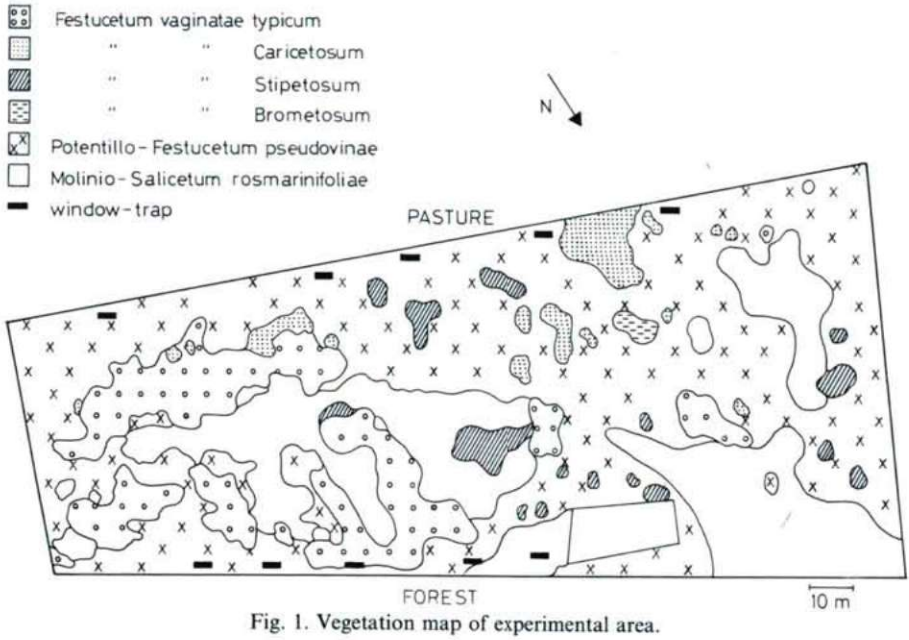


Fig. 1. Vegetation map of experimental area.

PROCESSING METHODS

1. For statistical evaluation of movement direction of populations entering or leaving the experimental area we used the maximum likelihood estimation of Bernoulli binomial distribution. We started from the proportion of the number of entering individuals to that of leaving individuals in case of both boundary zones. We examined the validity of the following two conditions:

a) We supposed, that the movement is undirected, in this case the number of individuals caught at opposite sides of the trap must be nearly the same, that can be controlled in the traps or in groups of traps.

b) If the movement is directed, the number of individuals at opposite sides of the traps would be different, and the direction of differences is the same.

2. Significant difference of the two sides was controlled also by chi-square test on the basis of class frequency ratio of 1:1.

For criterion of directionality we used $p<0.01$ significance level at percentage probability of undirectionality calculated by maximum likelihood estimation.

Fig. 2. shows the relationships between percentage probability of undirectionality and chi-square values of significant differences. Regarding the critical values of chi-square test the chosen 1% probability value falls between $0.025>p>0.01$ significance levels. Only the values less then this limit were regarded as significant directionality. This range was divided into 3 tracks for further refinement of significance levels (see fig. 6. A—B and fig. 8. A—B).

## Results

On the basis of results of provisory collections the distribution of *Auchenorrhyncha* individuals in 0—50, 50—100 and 100—150 cm strata was 84.8%, 8.2% and 7.0%, respectively. This was calculated from 1696 individuals collected in 1981. In 1982 the distribution of 13895 collected imagos in the 0—50 and 50—100

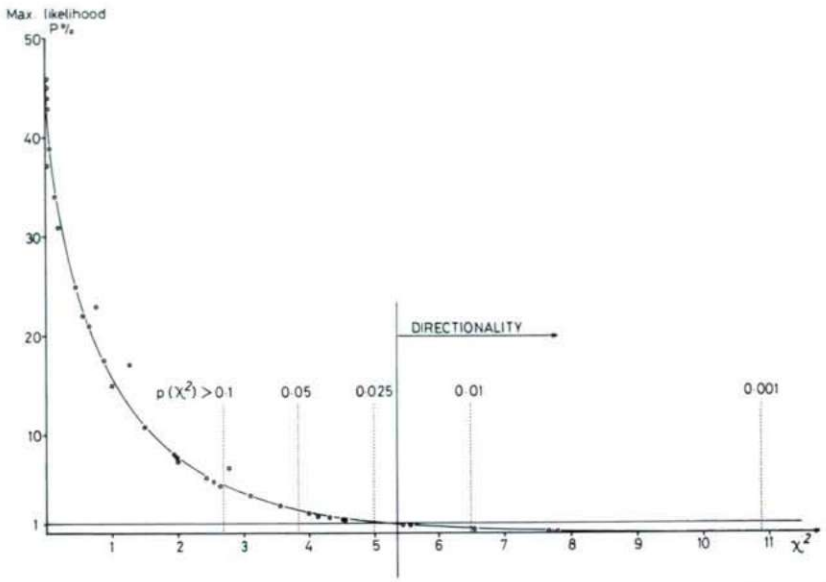


Fig. 2. Relationship between probability values (P%) of undirectionality calculated with maximum likelihood method and chi-square values of significant difference. Dotted lines sign significance levels of chi-square test.

cm strata was: 84% and 16%, respectively. Individuals of only 8 species occurred exclusively in one of the upper dishes, 16 specimens all. In the case of *Acridoidea* only 3.9% of all individuals occurred in the upper dishes.

Above results and larger scale stratification-examinations from WALOFF (1984), WEBER and WILSON (1981) and GÜNTHART (1988) show that the movement activity of insects in the grass or herb layer is best observable in the 0—50 cm stratum. In the followings we shall consider the material of these traps only.

## I. TURNOVER OF INDIVIDUALS IN THE BOUNDARY ZONES

### 1. *Qualitative and quantitative distribution according to the directions of traps*

In both experimental year (1982—83) 41689 *Auchenorrhyncha* individuals and 12966 *Acridoidea* imagos were collected. In addition the number of grasshopper nymphs is signed (though probably the efficiency of traps is less in this case), since their movement directionality was very similar to that of adults. The individual number of nymphs was not more then 882. Tables 1—4. of Appendix show the species composition of collected material and the sex ratio of imagos.

We found 118 *Auchenorrhynca* species altogether in the collected material. The largest species number was recorded at the forest side in both years (108 and 113), while at the pasture side individuals of 95 and 88 species were collected, respectively.

*Table 1.* Individual number of species collected in 1982. *(Auchenorrhyncha)*

| Species | 1982 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Forest | | Plot | | Pasture | | Plot | |
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| *CICADELLIDAE* | | | | | | | | |
| *Aconurella quadrum* H. S. | 1 | — | — | — | — | — | — | — |
| *Agallia laevis* RIB. | 7 | 3 | 6 | 2 | 31 | 3 | 11 | 1 |
| *Allygus atomarius* FABR. | — | — | 1 | — | — | — | — | — |
| *Allygus commutatus* FIEB. | — | 1 | — | 1 | — | — | — | — |
| *Allygus mixtus* FABR. | — | 1 | — | — | — | — | — | — |
| *Anaceratagallia ribauti* OSS. | 6 | 4 | 6 | 3 | 9 | 4 | 11 | 3 |
| *Anoscopus albiger* GERM. | — | — | — | — | — | — | — | — |
| *Anoscopus histrionicus* FABR. | — | 1 | 1 | — | — | — | — | — |
| *Anoscopus serratulae* FABR. | — | — | — | — | — | — | — | — |
| *Aphrodes bicinctus* SCHR. | 1 | 1 | — | — | 23 | 3 | 21 | 5 |
| *Arboridia parvula* BOH. | 8 | 2 | 2 | 1 | 7 | 2 | 1 | 5 |
| *Arocephalus lanquidus* FLOR. | 3 | 2 | 1 | 1 | 5 | 6 | 3 | 3 |
| *Arthaldeus pascuellus* FALL. | — | — | 1 | — | — | — | — | — |
| *Arthaldeus striifrons* KIRSCHB. | 1 | — | 1 | — | 1 | — | 1 | — |
| *Artianus interstitialis* GERM. | 28 | 10 | 23 | 9 | 17 | 6 | 26 | 6 |
| *Athysanus argentarius* METC. | 1 | 1 | 1 | — | — | — | — | 1 |
| *Austroagallia sinuata* M. R. | 12 | 12 | 38 | 14 | 12 | 4 | 12 | 5 |
| *Balclutha rhenana* WAGN. | 1 | — | 1 | — | — | — | 1 | 1 |
| *Batracomorphus irroratus* LEW. | 2 | 2 | 1 | 1 | 3 | 2 | 7 | 8 |
| *Bobacella corvina* HORV. | 182 | 67 | 104 | 75 | 77 | 30 | 102 | 54 |
| *Chlorita dumosa* RIB. | 30 | 5 | 20 | 13 | 64 | 42 | 66 | 39 |
| *Chlorita hungarica* RIB. | — | — | — | — | — | — | — | — |
| *Chlorita paolii* OSS. | 29 | 10 | 7 | 4 | 30 | 10 | 17 | 7 |
| *Cicadella viridis* L. | 2 | — | 1 | — | 1 | 1 | — | 1 |
| *Cicadula quadrinotata* FABR. | — | 1 | — | 1 | — | — | 1 | 1 |
| *Deltocephalus pulicaris* FALL. | 1 | 1 | — | — | — | — | 1 | — |
| *Dikraneura similis* EDW. | — | — | — | — | 1 | — | — | — |
| *Doratura exilis* HORV. | 6 | 1 | 5 | 3 | 8 | 1 | 10 | 2 |
| *Doratura heterophyla* HORV. | 5 | 2 | 3 | 1 | 20 | 1 | 18 | 1 |
| *Doratura homophyla* FLOR. | 51 | 23 | 31 | 26 | 163 | 39 | 132 | 18 |
| *Doratura impudica* HORV. | 1 | — | — | — | — | — | — | — |
| *Doratura stylata* BOH. | 42 | 11 | 48 | 9 | 45 | 25 | 47 | 16 |
| *Dryodurgades dlabolai* WAGN. | 2 | 3 | 2 | — | — | 1 | — | 3 |
| *Edwardsiana candidula* KIRSCHB. | 9 | — | 10 | 3 | 4 | — | 2 | — |
| *Edwardsiana rosae* L. | — | — | — | — | — | 1 | — | — |
| *Emelyanoviana mollicula* BOH. | 25 | 15 | 27 | 29 | 8 | 9 | 6 | 3 |
| *Errastunus notatifrons* KIRSCHB | — | — | — | — | 1 | — | — | — |
| *Erythroneura discolor* HORV. | 1 | — | 1 | — | — | — | — | 1 |
| *Eupelix cuspidata* FABR. | 20 | 4 | 26 | 3 | 26 | 6 | 14 | 2 |
| *Eupteryx aurata* L. | 4 | 7 | 5 | 8 | 9 | 15 | 4 | 8 |
| *Eupteryx collina* FLOR. | — | — | — | — | — | — | 1 | — |
| *Eupteryx notata* CURT. | 10 | 2 | 7 | 2 | 16 | 4 | 20 | 7 |
| *Eupteryx stachydearum* HARDY | 6 | 9 | 3 | 4 | 2 | 3 | 2 | 3 |
| *Eupteryx thoulessi* EDW. | 26 | 18 | 11 | 10 | 3 | 4 | 6 | 5 |
| *Euscelidius schenckii* KIRSCHB. | — | — | — | 1 | 1 | — | 1 | — |
| *Euscelis incisus* KIRSCHB. | 24 | 9 | 19 | 6 | 58 | 15 | 48 | 13 |
| *Goniagnathus brevis* H. S. | 11 | 4 | 8 | 4 | 31 | 5 | 19 | 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Graphocraerus ventralis* FALL. | 13 | 4 | 7 | 1 | 14 | 5 | 16 | 4 |
| *Handianus ignoscus* MEL. | — | — | — | — | — | — | — | — |
| *Hardyopsis insularis* LINDB. | 1 | 3 | 3 | 2 | — | 1 | — | 2 |
| *Hecalus glaucescens* FIEB. | 47 | 8 | 87 | 7 | 293 | 21 | 109 | 20 |
| *Idiocerus albicans* KIRSCHB. | 1 | — | 2 | 1 | — | 2 | — | — |
| *Idiocerus decimusquartus* SCHRK. | — | — | — | 1 | — | — | — | — |
| *Idiocerus distinquendus* KIRSCHB. | 1 | — | — | — | 2 | — | — | — |
| *Idiocerus humilis* HORV. | — | — | 1 | — | — | — | 1 | — |
| *Idiocerus populi* L. | 5 | 4 | 14 | 12 | 1 | 2 | 1 | 1 |
| *Jassargus obtusivalvis* KIRSCHB. | 10 | 5 | 7 | 2 | 1 | — | 1 | — |
| *Jassargus sursumflexus* THEN. | — | 9 | 1 | 3 | — | 2 | 1 | 1 |
| *Kybos abstrusa* LINN. | 25 | — | 12 | — | 4 | — | 5 | — |
| *Limotettix striola* FALL. | — | — | — | — | 1 | — | — | — |
| *Limotettix transversus* FALL. | — | — | 1 | — | — | — | — | — |
| *Macropsis impura* BOH. | 2 | — | 2 | — | — | — | — | — |
| *Macropsis vicina* HORV. | 2 | — | — | — | — | — | — | — |
| *Macrosteles laevis* RIB. | — | 1 | 1 | — | — | — | 1 | — |
| *Macrosteles quadripunctulatus* KIRSCHB. | 1 | — | — | — | — | — | — | — |
| *Macustus grisescens* ZETT. | 222 | 79 | 118 | 54 | 40 | 16 | 32 | 20 |
| *Megophtalmus scanicus* FALL. | — | — | 1 | — | — | — | 1 | — |
| *Mendrausus pauxillus* FIEB. | 161 | 31 | 103 | 30 | 263 | 39 | 237 | 37 |
| *Micantulina stigmatipennis* M. R. | 47 | 15 | 47 | 19 | 238 | 157 | 186 | 109 |
| *Mocuellus collinus* BOH. | — | — | — | — | 1 | 1 | — | — |
| *Mocuellus metrius* FLOR. | — | — | — | — | — | — | 1 | — |
| *Mocydia crocea* H. S. | 1 | 1 | — | — | — | — | — | — |
| *Mocydiopsis attenuata* GERM. | — | — | — | — | — | — | — | — |
| *Mocydiopsis parvicauda* RIB. | — | 1 | 2 | — | — | 1 | — | — |
| *Neoaliturus fenestratus* H. S. | 7 | 13 | 9 | 8 | 9 | 10 | 11 | 9 |
| *Neoaliturus haematoceps* M. R. | 2 | 2 | — | 1 | 11 | 6 | 12 | 3 |
| *Oncopsis* sp. | — | — | — | — | — | — | — | — |
| *Paluda preyssleri* H. S. | 1 | — | 4 | — | — | 1 | 1 | 1 |
| *Paluda vitripennis* FLOR. | 60 | 16 | 62 | 27 | 97 | 40 | 65 | 43 |
| *Paralimnus phragmitis* BOH. | — | 1 | — | — | — | — | — | — |
| *Paramesus obtusifrons* STAL | — | 2 | — | — | — | — | — | — |
| *Penthimia nigra* GOEZE | — | — | 1 | — | — | — | — | 1 |
| *Planaphrodes elongatus* LETH. | 77 | 33 | 89 | 50 | 68 | 28 | 112 | 41 |
| *Platymetopius major* KIRSCHB. | — | 1 | — | — | — | — | — | — |
| *Platymetopius undatus* DE GEER | — | — | — | — | — | — | — | 1 |
| *Psammotettix alienus* DHLB. | 5 | — | 5 | 1 | 11 | 3 | 8 | 4 |
| *Psammotettix confinis* DHLB. | 13 | 5 | 20 | 8 | 30 | 13 | 31 | 15 |
| *Psammotettix hungaricus* OROSZ | 1 | 1 | — | — | — | — | — | — |
| *Psammotettix pallidinervis* DHLB. | 8 | 5 | 12 | 4 | 3 | — | 5 | — |
| *Psammotettix provincialis* RIB. | 369 | 253 | 269 | 229 | 544 | 413 | 522 | 367 |
| *Psammotettix slovacus* DLAB. | 2 | 3 | 1 | — | 1 | 1 | 1 | 1 |
| *Recilia schmidtgeni* WAGN. | 276 | 24 | 234 | 18 | 711 | 27 | 596 | 45 |
| *Speudotettix subfusculus* FALL. | 3 | — | — | — | — | 2 | — | — |
| *Streptanus aemulans* KIRSCHB. | — | — | — | — | — | 1 | — | — |
| *Sroggylocephalus livens* ZETT. | — | — | — | — | — | — | — | — |
| *Tetartostylus pellucidus* WAGN. | — | — | 1 | 1 | — | 1 | — | — |
| *Turrutus socialis* FLOR. | 295 | 100 | 165 | 84 | 510 | 152 | 538 | 165 |
| *Ulopa lugens* GERM. | — | — | — | — | — | — | — | — |
| *Ulopa trivia* GERM. | 10 | 4 | 5 | 1 | 4 | 2 | 4 | 1 |
| *Zygina lunaris* M. R. | 10 | 11 | 20 | 10 | 1 | 2 | 1 | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Zygina nivea* M. R. | — | — | — | — | — | — | — | — |
| *Zygina tithide* FERR. | — | 5 | 1 | 3 | — | — | — | — |
| *Zyginidia pullula* BOH. | 100 | 41 | 67 | 40 | 112 | 94 | 91 | 56 |
| *DELPHACIDAE* | | | | | | | | |
| *Delphacodes albifrons* FIEB. | — | — | 1 | — | — | — | — | — |
| *Dicranotropis hamata* BOH. | — | — | — | — | — | — | — | — |
| *Ditropsis flavipes* SIGN. | — | — | — | — | 1 | — | — | — |
| *Euconomelus lepidus* BOH. | — | 1 | — | — | 1 | — | — | — |
| *Eurybregma nigrolineata* SCOTT | — | — | — | — | — | — | 1 | — |
| *Eurysula lurida* FIEB. | 1 | 5 | 1 | 6 | 1 | 5 | — | 3 |
| *Falcotoya minuscula* HORV. | 37 | 74 | 45 | 50 | 46 | 66 | 46 | 83 |
| *Gravesteiniella boldi* SCOTT | 74 | 78 | 77 | 83 | 16 | 12 | 26 | 30 |
| *Hyledelphax elegantulus* BOH. | 1 | — | — | — | — | — | — | — |
| *Jassidaeus lugubris* SIGN. | 19 | 13 | 11 | 8 | 5 | 2 | 21 | 25 |
| *Javesella dubia* KIRSCHB. | — | — | — | — | — | — | — | — |
| *Javesella pellucida* FABR. | 1 | 3 | 3 | 2 | 2 | 2 | — | 3 |
| *Kelisia brucki* FIEB. | — | — | — | 1 | — | — | 1 | — |
| *Kelisia monoceros* RIB. | 2 | — | 1 | — | — | — | — | — |
| *Kelisia pallidula* BOH. | 1 | — | — | — | 1 | — | — | — |
| *Kelisia perrieri* RIB. | — | — | — | — | — | 3 | — | — |
| *Kelisia ribauti* WAGN. | — | — | — | — | — | — | — | — |
| *Kosswigianella exiqua* BOH. | 3 | 15 | 24 | 19 | — | 1 | — | — |
| *Megadelphax sordidulus* STAL | — | — | — | — | — | — | — | — |
| *Metadelphax propinqua* FIEB. | 2 | 5 | 4 | 5 | 3 | 9 | 5 | 12 |
| *Muellerianella fairmairei* PERR. | 2 | — | 1 | 1 | 1 | — | — | — |
| *Muirodelphax aubei* PERR. | 1 | — | — | — | — | — | — | — |
| *Ribautodelphax albostriata* FIEB. | 4 | — | — | 1 | — | — | — | 1 |
| *Ribautodelphax imitans* RIB. | — | — | 1 | — | — | — | — | — |
| *Stenocranus minutus* FABR. | — | — | — | — | — | — | — | — |
| *Struebingianella palliceps* HORV. | — | — | — | — | — | — | — | — |
| *Weidnerianella marginata* FALL. | 17 | 11 | 26 | 22 | 12 | 9 | 17 | 11 |
| *Xanthodelphax straminea* STAL | — | — | — | — | — | — | 1 | 1 |
| *TETTIGOMETRIDAE* | | | | | | | | |
| *Tettigometra atra* HGBACH. | — | — | — | — | — | — | — | — |
| *Tettigometra concolor* FIEB. | 1 | — | — | — | — | — | — | — |
| *Tettigometra suphurea* M. R. | 1 | — | 1 | — | — | — | — | — |
| *CERCOPIDAE* | | | | | | | | |
| *Aphrophora alni* FALL. | — | 3 | — | — | — | — | — | — |
| *Aphrophora salicina* GOEZE | 1 | — | — | — | — | — | — | — |
| *Lepyronia coleoptrata* L. | 26 | 20 | 15 | 21 | 22 | 11 | 25 | 11 |
| *Neophilaenus campestris* FALL. | 8 | 10 | 3 | 4 | 25 | 21 | 13 | 22 |
| *Neophilaenus lineatus* L. | 4 | 2 | 1 | 2 | — | — | — | — |
| *Neophilaenus minor* KIRSCHB. | — | — | — | — | — | 1 | — | 1 |
| *Philaenus spumarius* L. | 9 | 12 | 6 | 9 | 8 | 4 | 16 | 15 |
| *TROPIDUCHIDAE* | | | | | | | | |
| *Trypetimorpha fenestrata* COSTA | 4 | 3 | 4 | 1 | 1 | 1 | 2 | 1 |
| *ISSIDAE* | | | | | | | | |
| *Ommatidiotus dissimilis* FALL. | 48 | 28 | 39 | 28 | 14 | 17 | 23 | 14 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *ACHILIDAE* | | | | | | | | |
| *Cixidia marginicollis* SPIN. | — | — | — | — | 1 | — | — | — |
| *MEMBRACIDAE* | | | | | | | | |
| *Stictocephala bisonia* K. Y. | — | — | — | — | — | — | — | — |
| *CIXIIDAE* | | | | | | | | |
| *Pentastiridius leporinus* L. | — | — | — | 2 | 2 | 1 | 1 | — |
| *DICTYOPHARIDAE* | | | | | | | | |
| *Chanithus pannonicus* GERM. | — | — | — | — | — | — | 1 | — |
| Total | 2603 | 1196 | 2059 | 1115 | 3809 | 1449 | 3400 | 1409 |

*Table 2.* Individual number of species collected in 1983. *(Auchenorrhyncha)*
1983

| Species | Forest | | Plot | | Pasture | | Plot | |
|---|---|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| *CICADELLIDAE* | | | | | | | | |
| *Aconurella quadrum* H. S. | — | — | 1 | — | — | — | — | — |
| *Agallia laevis* RIB. | 63 | 23 | 108 | 18 | 139 | 14 | 67 | 18 |
| *Allygus atomarius* FABR. | — | — | — | — | — | — | — | — |
| *Allygus commutatus* FIEB. | — | — | — | 1 | — | — | — | — |
| *Allygus mixtus* FABR. | — | — | — | — | — | — | — | — |
| *Anaceratagallia ribauti* OSS. | 30 | — | 46 | 1 | 35 | 5 | 17 | 3 |
| *Anoscopus albiger* GERM. | 1 | — | — | — | — | — | — | — |
| *Anoscopus histrionicus* FABR. | 1 | — | — | — | — | — | — | — |
| *Anoscopus serratulae* FABR. | 1 | — | — | — | 1 | — | — | — |
| *Aphrodes bicinctus* SCHR. | — | 2 | — | 1 | 2 | 2 | 3 | 1 |
| *Arboridia parvula* BOH. | — | 1 | 2 | 1 | 1 | 1 | 2 | — |
| *Arocephalus lanquidus* FLOR. | 28 | 15 | 17 | 10 | 9 | 7 | 3 | 4 |
| *Arthaldeus pascuellus* FALL. | — | — | — | — | — | — | — | — |
| *Arthaldeus striifrons* KIRSCHB. | 2 | — | 1 | — | — | — | 1 | 1 |
| *Artianus interstitialis* GERM. | 30 | 22 | 36 | 10 | 64 | 11 | 34 | 16 |
| *Athysanus argentarius* METC. | — | — | — | — | — | — | — | — |
| *Austroagallia sinuata* M. R. | 19 | 57 | 105 | 66 | 35 | 29 | 25 | 20 |
| *Balclutha rhenana* WAGN. | — | — | — | — | — | 1 | — | — |
| *Batracomorphus irroratus* LEW. | 1 | 1 | — | 1 | 10 | 9 | 4 | 8 |
| *Bobacella corvina* HORV. | 114 | 82 | 94 | 119 | 66 | 39 | 62 | 60 |
| *Chlorita dumosa* RIB. | 77 | 24 | 36 | 22 | 59 | 25 | 51 | 13 |
| *Chlorita hungarica* RIB. | — | — | — | — | — | 1 | — | — |
| *Chlorita paolii* OSS. | 318 | 18 | 152 | 15 | 93 | 20 | 92 | 19 |
| *Cicadella viridis* L. | 1 | — | — | 1 | — | — | — | — |
| *Cicadula quadrinotata* FABR. | — | — | — | — | — | — | — | — |
| *Deltocephalus pulicaris* FALL. | 4 | 8 | 1 | 4 | 3 | 7 | 1 | 6 |
| *Dikraneura similis* EDW. | 1 | — | — | — | 1 | — | 1 | — |
| *Doratura exilis* HORV. | 4 | — | — | — | — | — | — | — |
| *Doratura heterophyla* HORV. | 5 | 3 | 4 | 1 | — | 1 | — | — |
| *Doratura homophyla* FLOR. | 17 | 13 | 17 | 17 | 248 | 53 | 226 | 56 |
| *Doratura impudica* HORV. | 3 | 1 | 5 | 3 | — | — | — | — |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Doratura stylata* BOH. | 76 | 17 | 62 | 16 | 57 | 17 | 46 | 14 |
| *Dryodurgades dlabolai* WAGN. | 1 | 3 | — | 2 | 1 | 2 | 1 | — |
| *Edwardsiana candidula* KIRSCHB. | 5 | 1 | 2 | 1 | — | — | 1 | — |
| *Edwardsiana rosae* L. | — | — | — | — | — | — | — | — |
| *Emelyanoviana mollicula* BOH. | 71 | 30 | 50 | 26 | 5 | 5 | 8 | 4 |
| *Errastunus notatifrons* KIRSCHB | 1 | — | 1 | — | — | — | — | — |
| *Erythroneura discolor* HORV. | — | — | — | — | — | — | — | — |
| *Eupelix cuspidata* FABR. | 50 | 4 | 65 | 17 | 53 | 6 | 67 | 10 |
| *Eupteryx aurata* L. | 8 | 3 | 5 | 2 | 1 | 4 | — | 5 |
| *Eupteryx collina* FLOR. | — | — | — | — | — | — | 1 | — |
| *Eupteryx notata* CURT. | 72 | 9 | 27 | 2 | 31 | 6 | 23 | 8 |
| *Eupteryx stachydearum* HARDY | — | 2 | 1 | 1 | 1 | — | 1 | — |
| *Eupteryx thoulessi* EDW. | 20 | 15 | 9 | 15 | 4 | 8 | 4 | 3 |
| *Euscelidius schenckii* KIRSCHB. | — | — | — | — | — | — | — | — |
| *Euscelis incisus* KIRSCHB. | 15 | 8 | 12 | 5 | 78 | 20 | 67 | 7 |
| *Goniagnathus brevis* H. S. | 46 | 6 | 40 | 7 | 69 | 11 | 69 | 5 |
| *Graphocraerus ventralis* FALL. | 13 | 1 | 7 | 5 | 12 | 4 | 12 | 6 |
| *Handianus ignoscus* MEL. | — | — | 1 | — | 1 | — | — | — |
| *Hardyopsis insularis* LINDB. | — | — | 1 | 1 | — | — | — | 1 |
| *Hecalus glaucescens* FIEB. | 115 | 23 | 92 | 20 | 398 | 31 | 320 | 34 |
| *Idiocerus albicans* KIRSCHB. | — | — | — | — | — | — | — | — |
| *Idiocerus decimusquartus* SCHRK. | — | 1 | 1 | — | — | — | — | 1 |
| *Idiocerus distinquendus* KIRSCHB. | — | — | — | — | — | — | — | — |
| *Idiocerus humilis* HORV. | — | — | — | — | — | — | — | — |
| *Idiocerus populi* L. | 7 | 5 | 2 | — | 2 | 4 | 2 | 4 |
| *Jassargus obtusivalvis* KIRSCHB. | 18 | 15 | 18 | 7 | 2 | — | 1 | 1 |
| *Jassargus sursumflexus* THEN. | — | — | — | 5 | — | — | — | — |
| *Kybos abstrusa* LINN. | 22 | 1 | 14 | 3 | 5 | — | 5 | — |
| *Limotettix striola* FALL. | — | — | — | — | — | — | — | — |
| *Limotettix transversus* FALL. | — | — | — | — | — | — | — | — |
| *Macropsis impura* BOH. | 1 | 2 | — | — | — | — | — | — |
| *Macropsis vicina* HORV. | — | — | — | — | — | — | — | — |
| *Macrosteles laevis* RIB. | 7 | 16 | 4 | 11 | — | 5 | 1 | 1 |
| *Macrosteles quadripunctulatus* KIRSCHB. | 1 | 1 | — | 1 | — | — | — | — |
| *Macustus grisescens* ZETT. | 88 | 31 | 83 | 37 | 12 | 9 | 13 | 4 |
| *Megophtalmus scanicus* FALL. | — | — | — | — | — | — | — | — |
| *Mendrausus pauxillus* FIEB. | 100 | 25 | 164 | 26 | 106 | 27 | 95 | 16 |
| *Micantulina stigmatipennis* M. R. | 14 | 5 | 23 | 6 | 20 | 14 | 29 | 21 |
| *Mocuellus collinus* BOH. | — | 3 | 2 | 2 | 1 | — | — | 1 |
| *Mocuellus metrius* FLOR. | — | — | — | — | — | — | — | — |
| *Mocydia crocea* H. S. | 2 | 2 | 5 | 1 | — | — | — | — |
| *Mocydiopsis attenuata* GERM. | 1 | — | — | — | — | — | — | — |
| *Mocydiopsis parvicauda* RIB. | — | — | 1 | — | — | — | — | — |
| *Neoaliturus fenestratus* H. S. | 42 | 16 | 40 | 7 | 16 | 20 | 12 | 5 |
| *Neoaliturus haematoceps* M. R. | 4 | — | — | 3 | 5 | 3 | 8 | 8 |
| *Oncopsis* sp. | — | 2 | 1 | 2 | — | 4 | 1 | 1 |
| *Paluda preyssleri* H. S. | 6 | — | 7 | 1 | 1 | — | — | — |
| *Paluda vitripennis* FLOR. | 41 | 13 | 85 | 32 | 52 | 24 | 37 | 13 |
| *Paralimnus phragmitis* BOH. | — | — | — | — | — | — | — | — |
| *Paramesus obtusifrons* STAL | — | — | — | — | — | — | — | — |
| *Penthimia nigra* GOEZE | — | — | — | — | — | — | — | — |
| *Planaphrodes elongatus* LETH. | 8 | 12 | 18 | 15 | 10 | 8 | 3 | 11 |
| *Platymetopius major* KIRSCHB. | 1 | — | — | — | — | — | — | — |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Platymetopius undatus* DE GEER | — | — | — | — | — | — | 1 | — |
| *Psammotettix alienus* DHLB. | 13 | 7 | 9 | 2 | 7 | 2 | 7 | 5 |
| *Psammotettix confinis* DHLB. | 31 | 14 | 21 | 9 | 49 | 18 | 27 | 13 |
| *Psammotettix hungaricus* OROSZ | — | — | — | — | — | — | — | — |
| *Psammotettix pallidinervis* DHLB. | 24 | 10 | 22 | 11 | 25 | 10 | 31 | 16 |
| *Psammotettix provincialis* RIB. | 710 | 703 | 656 | 609 | 689 | 690 | 580 | 556 |
| *Psammotettix slovacus* DLAB. | 13 | 6 | 14 | 6 | 4 | 3 | 4 | 5 |
| *Recilia schmidtgeni* WAGN. | 561 | 96 | 368 | 61 | 1416 | 81 | 1392 | 113 |
| *Speudotettix subfusculus* FALL. | 2 | — | — | — | — | — | — | — |
| *Streptanus aemulans* KIRSCHB. | — | — | — | — | — | — | — | — |
| *Sroggylocephalus livens* ZETT. | — | 2 | — | 2 | 1 | 1 | — | 1 |
| *Tetartostylus pellucidus* WAGN. | — | — | — | — | — | — | — | — |
| *Turrutus socialis* FLOR. | 251 | 63 | 241 | 61 | 162 | 35 | 192 | 30 |
| *Ulopa lugens* GERM. | 1 | — | 1 | — | — | — | — | — |
| *Ulopa trivia* GERM. | 43 | 1 | 32 | — | 27 | — | 20 | 3 |
| *Zygina lunaris* M. R. | — | — | — | — | — | — | — | — |
| *Zygina nivea* M. R. | 2 | — | 1 | — | 1 | — | — | — |
| *Zygina tithide* FERR. | — | — | — | — | — | — | — | — |
| *Zyginidia pullula* BOH. | 187 | 96 | 125 | 142 | 95 | 46 | 55 | 55 |
| *DELPHACIDAE* | | | | | | | | |
| *Delphacodes albifrons* FIEB. | — | — | — | — | — | — | — | — |
| *Dicranotropis hamata* BOH. | — | — | 1 | — | — | — | — | — |
| *Ditropsis flavipes* SIGN. | 1 | — | — | — | — | — | — | — |
| *Euconomelus lepidus* BOH. | 2 | — | — | — | — | — | — | 1 |
| *Eurybregma nigrolineata* SCOTT | 1 | — | — | — | — | — | — | — |
| *Eurysula lurida* FIEB. | 2 | 7 | 1 | 5 | — | 3 | 2 | 4 |
| *Falcotoya minuscula* HORV. | 271 | 326 | 333 | 346 | 668 | 601 | 422 | 476 |
| *Gravesteiniella boldi* SCOTT | 97 | 108 | 118 | 122 | 8 | 16 | 9 | 14 |
| *Hyledelphax elegantulus* BOH. | 1 | — | 1 | — | — | — | — | — |
| *Jassidaeus lugubris* SIGN. | 5 | 6 | 3 | 4 | — | 2 | 2 | 3 |
| *Javesella dubia* KIRSCHB. | 1 | 1 | — | — | — | — | — | — |
| *Javesella pellucida* FABR. | 1 | 1 | — | — | — | 2 | — | — |
| *Kelisia brucki* FIEB. | — | 1 | — | 1 | 3 | — | 1 | 2 |
| *Kelisia monoceros* RIB. | — | — | 2 | 1 | 1 | 2 | — | — |
| *Kelisia pallidula* BOH. | — | — | 1 | — | — | — | 1 | — |
| *Kelisia perrieri* RIB. | — | 1 | — | — | — | — | — | — |
| *Kelisia ribauti* WAGN. | 1 | — | — | — | — | — | 1 | 1 |
| *Kosswigianella exiqua* BOH. | 6 | 9 | 4 | 6 | 6 | 10 | 8 | 6 |
| *Megadelphax sordidulus* STAL | 1 | — | — | — | — | — | — | — |
| *Metadelphax propinqua* FIEB. | 8 | 3 | 2 | 3 | 5 | 12 | 5 | 5 |
| *Muellerianella fairmairei* PERR. | — | — | — | — | — | — | — | — |
| *Muirodelphax aubei* PERR. | 1 | — | — | — | — | — | — | — |
| *Ribautodelphax albostriata* FIEB. | 2 | 2 | 3 | — | — | — | 1 | — |
| *Ribautodelphax imitans* RIB. | 1 | 1 | — | — | 1 | — | — | — |
| *Stenocranus minutus* FABR. | 1 | — | — | — | — | — | — | — |
| *Struebingianella palliceps* HORV. | 14 | 5 | 11 | 8 | — | 1 | — | — |
| *Weidnerianella marginata* FALL. | 3 | 10 | 1 | 5 | 3 | 1 | 5 | 5 |
| *Xanthodelphax straminea* STAL | — | — | — | — | — | — | — | — |
| *TETTIGOMETRIDAE* | | | | | | | | |
| *Tettigometra atra* HGBACH. | 1 | — | — | — | — | — | — | — |
| *Tettigometra concolor* FIEB. | — | — | — | — | — | — | — | — |
| *Tettigometra suphurea* M. R. | 1 | — | 1 | — | 1 | — | — | — |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *CERCOPIDAE* | | | | | | | | |
| *Aphrophora alni* FALL. | — | — | — | — | — | — | — | — |
| *Aphrophora salicina* GOEZE | — | — | — | — | — | — | — | — |
| *Lepyronia coleoptrata* L. | 25 | 23 | 34 | 14 | 33 | 19 | 31 | 29 |
| *Neophilaenus campestris* FALL. | 14 | 15 | 12 | 14 | 19 | 29 | 27 | 20 |
| *Neophilaenus lineatus* L. | 1 | 1 | 3 | 4 | 2 | 1 | 1 | — |
| *Neophilaenus minor* KIRSCHB. | — | — | 1 | 1 | — | — | — | — |
| *Philaenus spumarius* L. | 4 | 8 | 7 | 13 | 3 | 3 | 3 | 3 |
| *TROPIDUCHIDAE* | | | | | | | | |
| *Trypetimorpha fenestrata* COSTA | 16 | 5 | 5 | 2 | 1 | 1 | 1 | — |
| *ISSIDAE* | | | | | | | | |
| *Ommatidiotus dissimilis* FALL. | 27 | 21 | 16 | 22 | 16 | 12 | 22 | 16 |
| *ACHILIDAE* | | | | | | | | |
| *Cixidia marginicollis* SPIN. | 1 | 1 | 3 | — | — | — | 1 | 1 |
| *MEMBRACIDAE* | | | | | | | | |
| *Stictocephala bisonia* K. Y. | — | 1 | — | — | — | — | — | — |
| *CIXIIDAE* | | | | | | | | |
| *Pentastiridius leporinus* L. | — | — | — | 1 | 2 | 1 | 1 | 1 |
| *DICTYOPHARIDAE* | | | | | | | | |
| *Chanithus pannonicus* GERM. | 1 | — | 1 | — | 2 | — | 1 | — |
| Total | 3925 | 2096 | 3522 | 2045 | 4959 | 2059 | 4270 | 1793 |

*Table 3.* Individual number of species collected in 1982. *(Acridoidea)*

| Species | 1982 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Forest | | Plot | | Pasture | | Plot | |
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| *CATANTOPIDAE* | | | | | | | | |
| *Calliptamus italicus* L. | 6 | 2 | 1 | 1 | 24 | 11 | 31 | 14 |
| *Calliptamus barbarus* COSTA | 3 | 1 | 3 | 3 | 9 | 9 | 10 | 9 |
| Nymphs: | 5 | | 3 | | 19 | | 7 | |
| *ACRIDIDAE* | | | | | | | | |
| *Oedaleus decorus* GER. | — | — | — | — | — | — | 2 | 1 |
| Nymphs: | — | | — | | 2 | | — | |
| *Oedipoda coerulescens* L. | — | 1 | — | 2 | 3 | 2 | 1 | 2 |
| Nymphs: | — | | 1 | | 2 | | 1 | |
| *Dociostaurus brevicollis* EVER. | 22 | 11 | 16 | 6 | 11 | 8 | 12 | 8 |
| Nymphs: | 2 | | — | | — | | — | |
| *Stenobothrus (S.) crassipes* CHARP. | 44 | 15 | 56 | 19 | 93 | 26 | 30 | 10 |
| *Stenobothrus (S.) fischeri* EVER. | 18 | 13 | 13 | 11 | 8 | 9 | 13 | 4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Stenobothrus (S.) nigromaculatus* H. S. | 10 | 10 | 16 | 15 | 13 | 11 | 20 | 20 |
| Nymphs: | 2 | | 11 | | — | | — | |
| *Omocestus (O.) ventralis* ZETT. | 2 | — | 1 | 1 | 3 | — | — | 1 |
| *Omocestus (D.) haemorrhoidalis* CHARP. | 6 | — | 10 | — | 31 | 7 | 25 | 11 |
| Nymphs: | — | | — | | — | | — | |
| *Omocestus (D.) petraeus* BRIS. | 4 | 4 | 3 | 2 | 9 | 3 | 7 | 3 |
| *Myrmeleotettix antennatus* FIEB. | 5 | 2 | 1 | 1 | 1 | — | 1 | — |
| *Myrmeleotettix maculatus* THUNBG. | — | 2 | — | 1 | — | 3 | — | — |
| Nymphs: | — | | — | | — | | — | |
| *Chorthippus (G.) brunneus* THUNBG. | 9 | 1 | 11 | 4 | 24 | 6 | 12 | 2 |
| *Chorthippus (G.) mollis* CHARP. | 24 | 4 | 11 | 4 | 18 | 3 | 10 | — |
| *Chorthippus (Ch.) dichrous* EVER. | 2 | 1 | 7 | 1 | 7 | 6 | 6 | 3 |
| *Chorthippus (Ch.) dorsatus* ZETT. | 10 | 6 | 2 | 4 | 13 | 9 | 8 | 7 |
| *Chorthippus (Ch.) longicornis* LATR. | 28 | 16 | 27 | 16 | 60 | 19 | 25 | 11 |
| Nymphs: | — | | 2 | | — | | — | |
| *Euchorthippus pulvinatus* F. W. | 65 | 17 | 58 | 16 | 27 | 13 | 34 | 12 |
| *Euchorthippus declivus* BRIS. | 469 | 111 | 661 | 113 | 523 | 202 | 233 | 140 |
| Nymphs: | 9 | | 1 | | 4 | | 3 | |
| Total (adult) | 727 | 217 | 897 | 220 | 877 | 347 | 480 | 258 |
| Total (adult + nymph) | 962 | | 1135 | | 1251 | | 749 | |

*Table 4.* Individual number of species collected in 1983. *(Acridoidea)*

| Species | 1983 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Forest | | Plot | | Pasture | | Plot | |
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| *CATANTOPIDAE* | | | | | | | | |
| *Calliptamus italicus* L. | 22 | 1 | 13 | 4 | 26 | 8 | 15 | 7 |
| *Calliptamus barbarus* COSTA | 2 | 1 | — | 1 | 4 | 3 | 1 | 2 |
| Nymphs: | 37 | | 22 | | 129 | | 76 | |
| *ACRIDIDAE* | | | | | | | | |
| *Oedaleus decorus* GER. | 1 | — | 2 | — | — | — | 1 | — |
| Nymphs: | 7 | | — | | 1 | | 4 | |
| *Oedipoda coerulescens* L. | 3 | 2 | 4 | — | — | — | 1 | 1 |
| Nymphs: | 12 | | 5 | | 3 | | 14 | |
| *Dociostaurus brevicollis* EVER. | 33 | 8 | 13 | 10 | 29 | 18 | 14 | 4 |
| Nymphs: | 2 | | 2 | | — | | — | |
| *Stenobothrus (S.) crassipes* CHARP. | 66 | 2 | 66 | 3 | 92 | 27 | 34 | 4 |
| *Stenobothrus (S.) fischeri* EVER. | 24 | 25 | 14 | 26 | 34 | 32 | 30 | 44 |
| *Stenobothrus (S.) nigromaculatus* H. S. | 36 | 6 | 36 | 14 | 57 | 18 | 39 | 18 |
| Nymphs: | 14 | | 7 | | 5 | | 13 | |
| *Omocestus (O.) ventralis* ZETT. | — | — | — | — | — | — | — | — |
| *Omocestus (D.) haemorrhoidalis* CHARP. | 12 | — | 11 | 2 | 21 | 2 | 11 | 2 |
| Nymphs: | — | | — | | 5 | | 8 | |
| *Omocestus (D.) petraeus* BRIS. | 5 | 3 | 3 | — | 12 | 2 | 4 | 1 |
| *Myrmeleotettix antennatus* FIEB. | — | — | 3 | — | — | — | — | — |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Myrmeleotettix maculatus* THUNBG. | 1 | — | — | — | 1 | 1 | — | — |
| Nymphs: | 1 | | — | | — | | — | |
| *Chorthippus (G.) brunneus* THUNBG. | 16 | 5 | 21 | 7 | 10 | 8 | 5 | 3 |
| *Chorthippus (G.) mollis* CHARP. | 32 | 7 | 30 | 7 | 18 | 3 | 15 | 3 |
| *Chorthippus (Ch.) dichrous* EVER. | 4 | 2 | — | 1 | 5 | 8 | 3 | — |
| *Chorthippus (Ch.) dorsatus* ZETT. | 3 | — | 4 | 2 | 14 | 8 | 11 | 2 |
| *Chorthippus (Ch.) longicornis* LATR. | 88 | 56 | 170 | 105 | 213 | 140 | 88 | 39 |
| Nymphs: | 23 | | 30 | | 20 | | 28 | |
| *Euchorthippus pulvinatus* F. W. | 32 | 6 | 41 | 13 | 18 | 10 | 12 | 11 |
| *Euchorthippus declivus* BRIS. | 1144 | 218 | 1726 | 287 | 1820 | 563 | 550 | 238 |
| Nymphs: | 43 | | 48 | | 72 | | 177 | |
| Total (adult) | 1524 | 342 | 2157 | 482 | 2374 | 851 | 834 | 379 |
| Total (adult + nymph) | 2005 | | 2753 | | 3460 | | 1533 | |

At the forest side larger difference was measured in the number of species arriving from the two directions — number of entering species was 98 and 102, that of leaving ones was 87 and 91, respectively. At pasture side there was not considerable difference between the two directions. Here the number of entering species was 82 and 77, that of leaving ones was 80 and 76, respectively.

Quantitatively the movements to the direction of ungrazed area dominated in both boundary zones. The number of individuals from the forest exceeded that of emigrants by 19.8% (1982) and 8.2% (1983), and that from the pasture by 9.3% and 15.6%, respectively. Number of males was about 2.5 times larger than that of females in the distribution of individuals moving at the pasture side, but at the forest side we caught only about 1.9 times more males.

In totality the individual turnover was greater at the pasture side in both years, in 1982 it was greater about 1.5 times, and in 1983 1.13 times as high as that of forest side.

Species number of grasshoppers did not alter neither in respect of the two boundary zones, nor within them between the two directions. Species number was 20 everywhere with minimal replacement. Quantitatively we measured large inprush at the pasture side and lighter outprush at the forest side in both years. Traps collected more individuals by 65.8% (1982) and by 165.9% (1983) from the direction of pasture than from the ungrazed area. At the same time the number of individuals moving to the direction of forest was greater by 18.3% and 41.4%, respectively, than to the opposite direction. We found much more males than females (4x) among individuals moving at the forest side (in contradistinction to *Auchenorrhyncha*), but at the pasture side only 2.3 times more males were caught. The intensity of individual turnover within the boundary zones is almost same in the two years.

2. *Seasonal alteration of movement activity*

To study the temporal appearance and quality of general seasonal tendency, we calculated the catching quantities per day for each collecting period. So we obtained comparable data that can be seen at Fig. 3. and 4.

*Auchenorrhyncha* have maximal activity in May—June in both boundary zone in both year (Fig. 3.). This may be followed by a much lighter increase in August (this vas wery large at pasture in 1983), or in September—October (in the case of the forest in 1982).

At the forest side the surplus which directed to the experimental area appeared in the activity maximum. At the pasture side the entering surplus could be registered only in midsummer and in October, but not steady tendency was found in the other periods in respect of catching direction.

Very high peak of activity was measured in July in the movement of grasshoppers, that lasted in the beginning of August (Fig. 4.). Also a smaller peak

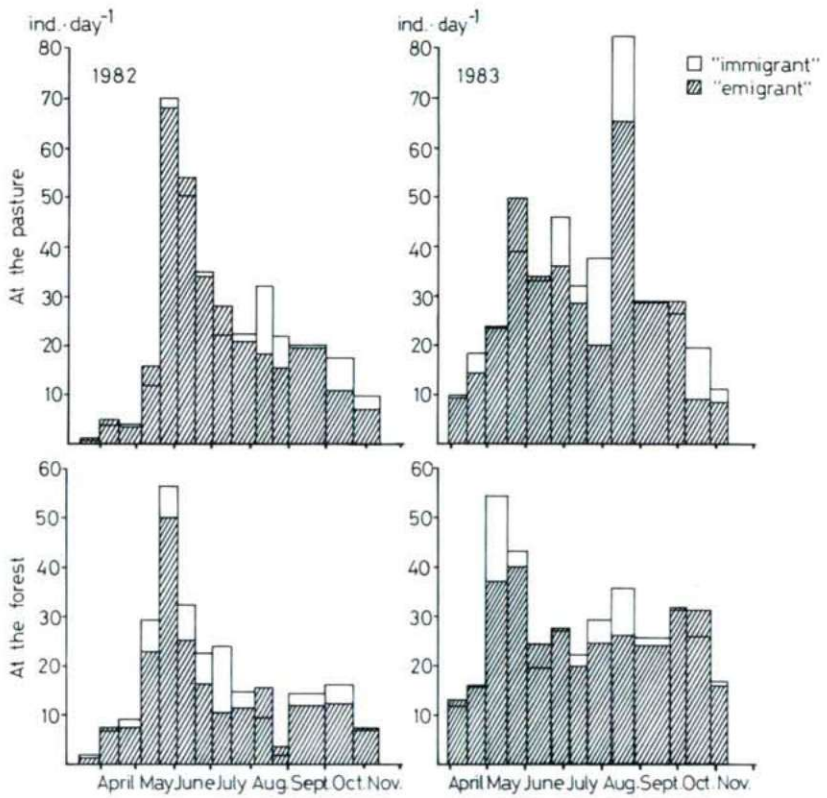


Fig. 3. Seasonal changes of individual number of *Auchenorrhyncha* imagos per day in both years, from data summed up according to trap directions.

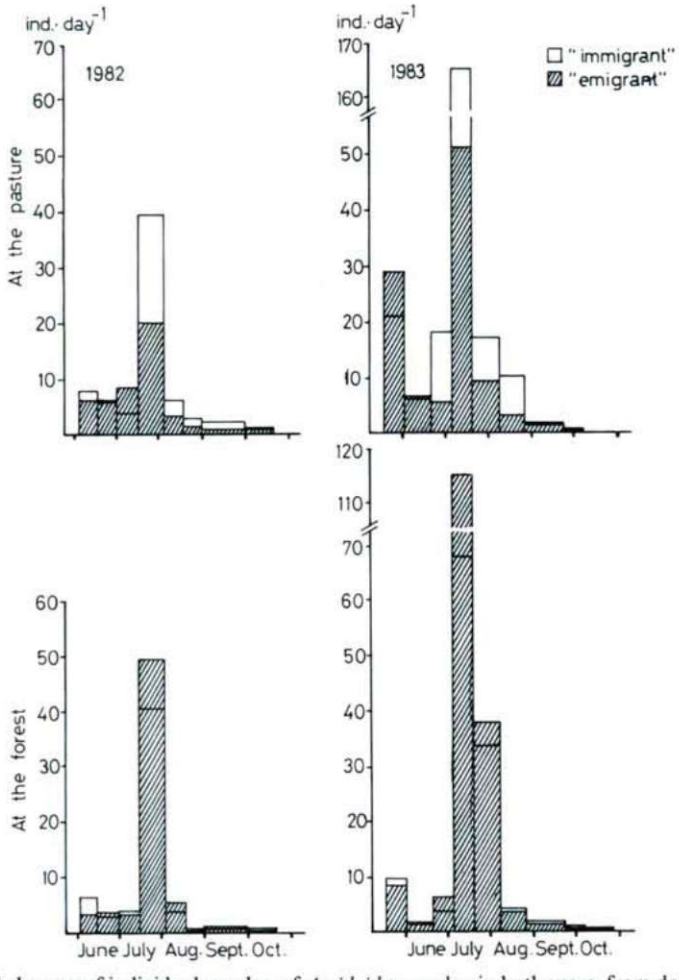


Fig. 4. Seasonal changes of individual number of *Acridoidea* per day in both years, from data summed up according to trap directions.

formed in May 1983 that was caused by larvae. (Data of the figures contain also larvae in the case of this group.)

Definite and consequent trend can be seen in the number of animals arriving from different directions after development and becoming dominant of imagos. This may be promoted by small species number. Continuous inrush could be measured at the pasture side until September, intensity of which was the largest at activity maximum. The outrush at the forest side was not so lasting and intensive.

## II. ESTIMATION OF MOVEMENT DIRECTIONALITY

In the course of evaluation of global data different trends of several populations may conceal, suppress each other, mainly in case of the *Auchenorrhyncha* community with large species number. That is why we examined the populations of dominant species one by one. Generations or subpopulations may behave in different manner. To determine activity periods we examined the seasonal percentage distribution of important species in the collected material (Fig. 5.A—C). The populations were divided into subpopulations on this basis. The place of division is marked by arrow at the connected activity curves.

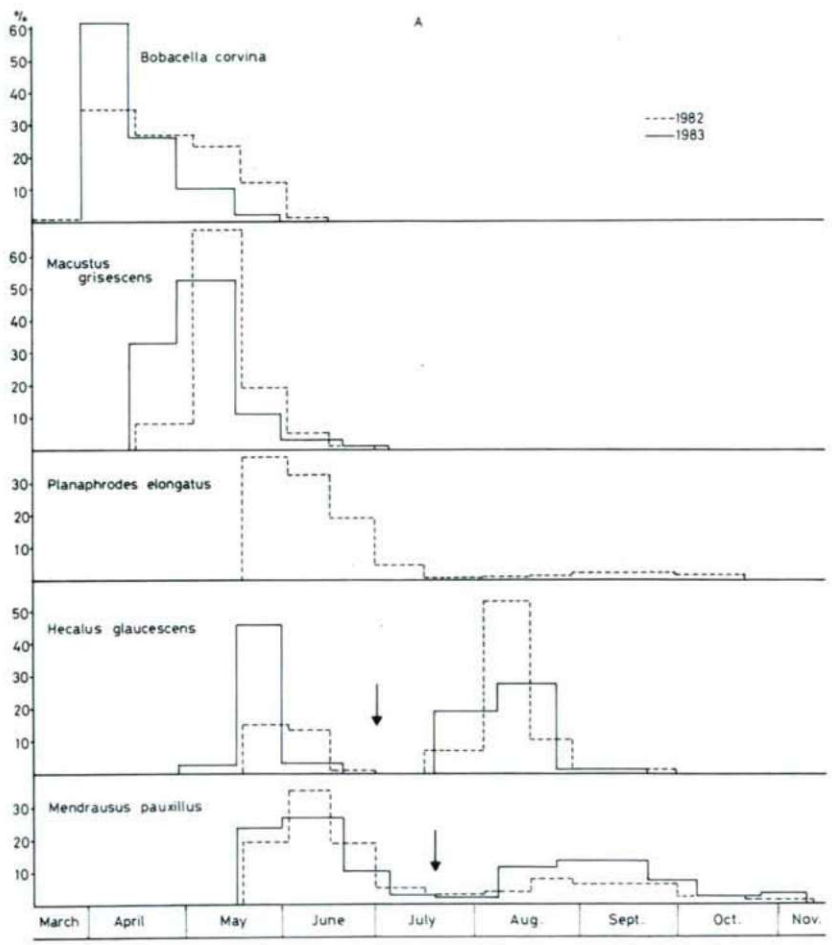


Fig. 5.A) Seasonal distribution of dominant *Auchenorrhyncha* species. (Arrows indicate the division of subpopulations.)

Thus the movement directionality was calculated separately for the distinguished periods. The summarized results are shown by Fig. 6.A—B. Quantitatively the inrush predominated at both side in case of *Auchenorrhyncha*, number of species moving significantly to the direction of pasture was 6, that of species moving to the direction of forest was 7. At the same time 10 species entered the sampling area from the pasture and 7 from the forest.

It seems from the joint evaluation of two kinds of figures, that three activity periods distinguished in the case of *Auchenorrhyncha*. These are March—May, June—August and September—October.

In the spring aspect the outrush predominated at the pasture side (*Bobacella corvina, Planaphrodes elongatus, Hecalus glaucescens, Psammotettix provincialis* and *Recilia schmidtgeni*), while at the forest side the inrush was dominant (*Bobacella corvina, Macustus grisescens, Zyginidia pullula, Chlorita paolii, Psammotettix*

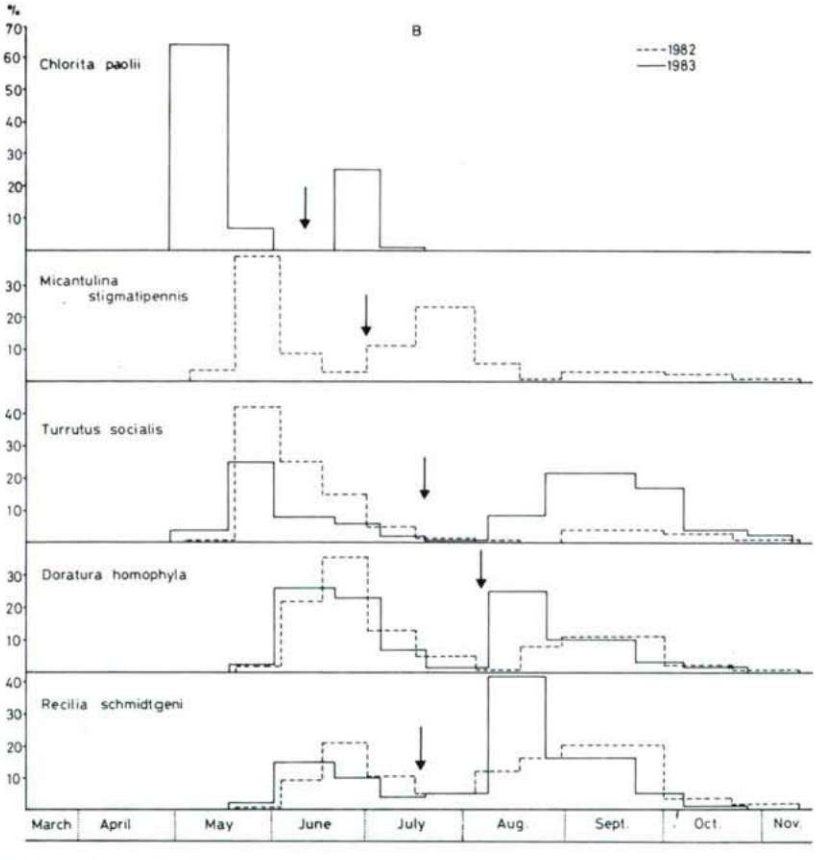


Fig. 5.B) Seasonal distribution of dominant *Auchenorrhyncha* species. (Arrows indicate the division of subpopulations.)

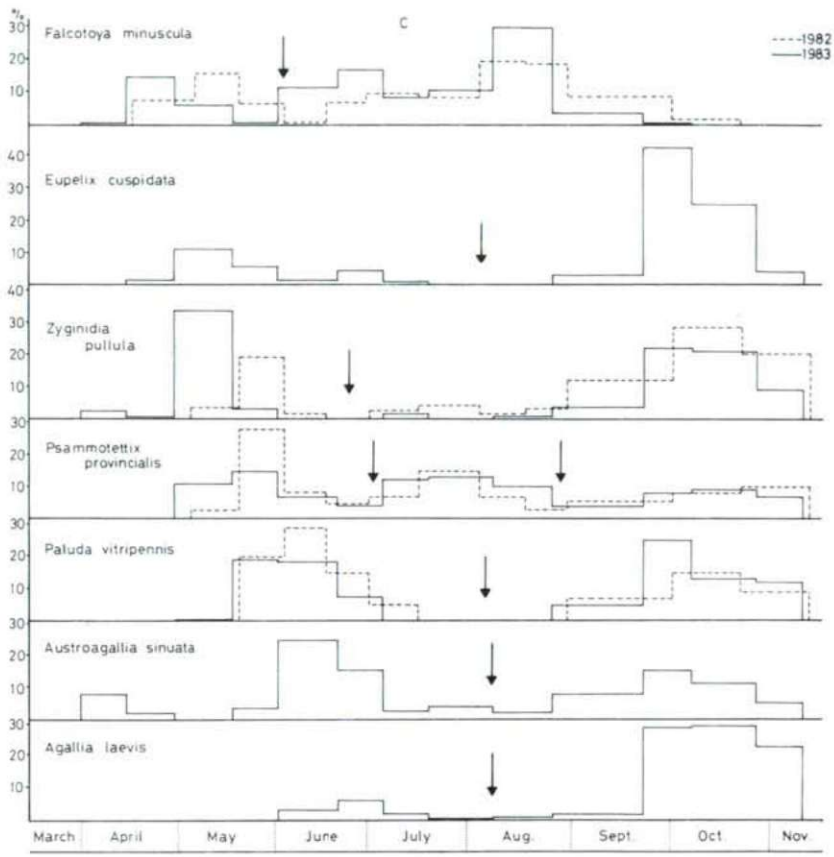


Fig. 5.C) Seasonal distribution of dominant *Auchenorrhyncha* speices. (Arrows indicate the division of subpopulations.)

*provincialis, Turrutus socialis, Recilia schmidtgeni)*. This trend directing to the pasture turned over in the summer months. The movement activity decreased in the warmest period of July. The attractive effect of the experimental area increased that can be measured on the inrush from the pasture in case of *Falcotoya minuscula, Paluda vitripennis, Micantulina stigmatipennis, Doratura homophyla, Psammotettix provincialis, Hecalus glaucescens* and *Mendrausus pauxillus*. At the forest side the outrush predominated in the populations of *Falcotoya minuscula, Paluda vitripennis, Austroagallia sinuata* and *Mendrausus pauxillus*.

In the autumn months the trends were not so clear. Only *Eupelix cuspidata* moved towards the pasture, while inrush of *Zyginidia pullula, Agallia laevis* and *Recilia schmidtgeni* could be measured. At the forest side two species moved from the forest (*Turrutus socialis* and *Recilia schmidtgeni*), the others moved in the

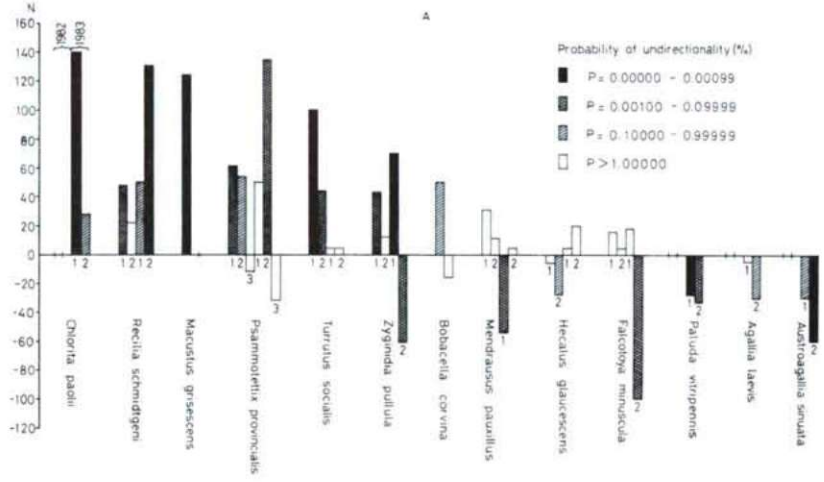


Fig. 6.A) Differences of numbers of „immigrant" and „emigrant" individuals of dominant *Auchenorrhyncha* species at forest side, from data summed up according to subpopulations (1,2,3). Graphs of the two experimental years are separated.

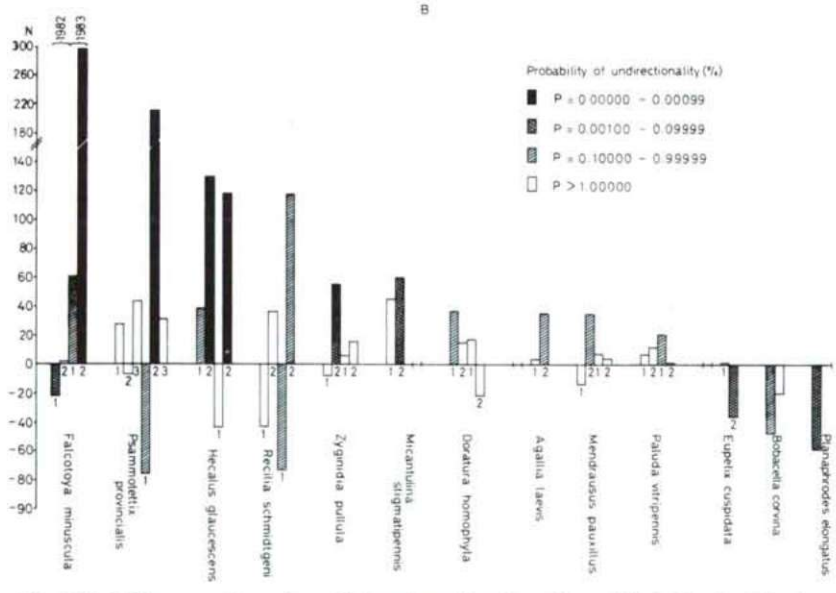


Fig. 6.B) Differences of numbers of „immigrant" and „emigrant" individuals of dominant *Auchenorrhyncha* species at pasture side, from data summed up according to subpopulations (1,2,3). Graphs of the two experimental years are separated.

direction of forest (*Zyginidia pullula, Paluda vitripennis, Agallia laevis, Austroagallia sinuata*).

The seasonal activity peaks of adults of the three most abundant *Acridoidea* populations (*Euchorthippus declivus, Chorthippus longicornis* and *Stenobothrus crassipes*) appeared equally in July (Fig. 7.A-C), but the maximal activity of *S. crassipes* may shift over August (see in 1983). It is evident, that these three populations are responsible for seasonal movement trends characteristic for whole *Acridoidea* fauna, which is shown at Fig. 4. The single directionalities are nearly the same. Deviation was found in the case of *S. crassipes* at forest boundary, where the

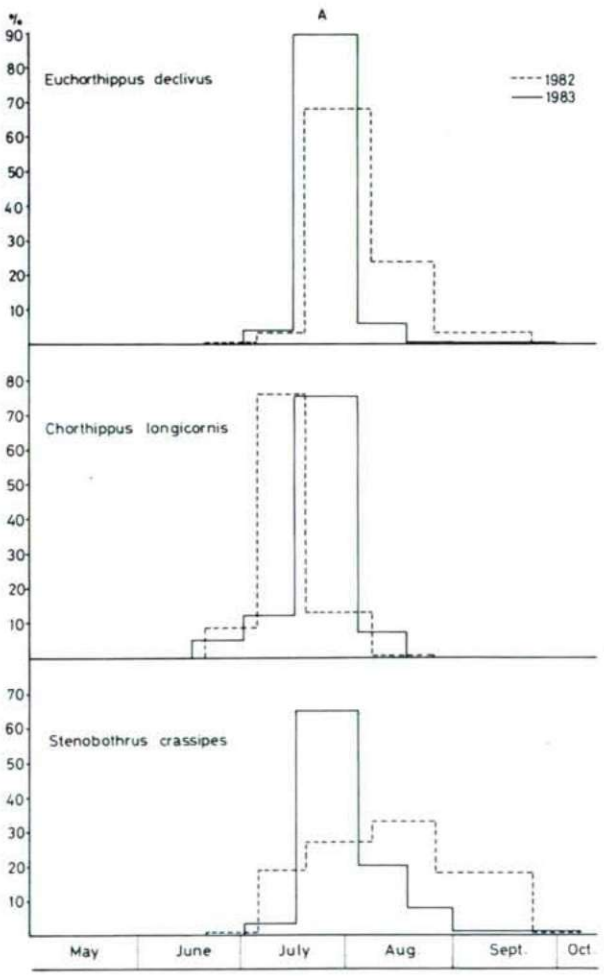


Fig. 7.A) Seasonal distribution of imagos of grasshopper populations.

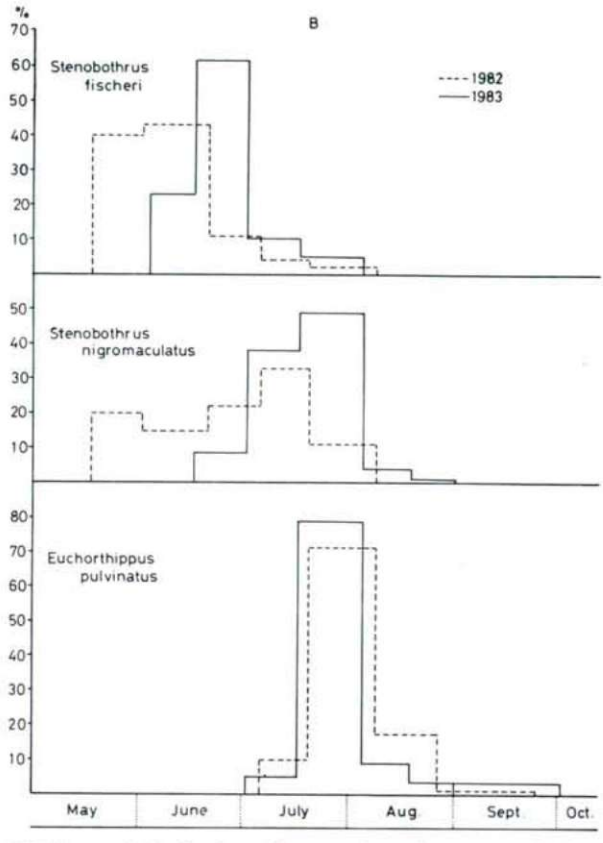


Fig. 7.B) Seasonal distribution of imagos of grasshopper populations.

significance of directionality decreased, and in the case of *C. longicornis* only the direction could be detected in 1982 (probably because of low individual number). In totality significant and intense inrush from the pasture and less intense, but significant outrush to the forest happened additively in both years in case of these three populations. This scheme of directionality of pasture ⇨ forest in reflection of individual turnover passing through the boundary zones is shown by Fig. 8.A-B. These figures demonstrate well the very diverse proportions of the populations.

The distribution of individuals of *Stenobothrus fischeri*, *S. nigromaculatus* and *Euchorthippus pulvinatus* populations, density of which was less then that of species mentioned above, was more balanced at the two sides of traps. Between the sides of traps such effects stood out that were opposite and suppressed directionality. Movement of these populations is qualified undirectional on the basis of the analysis. Seasonal segregation may have a role in this in addition to the above mentioned.

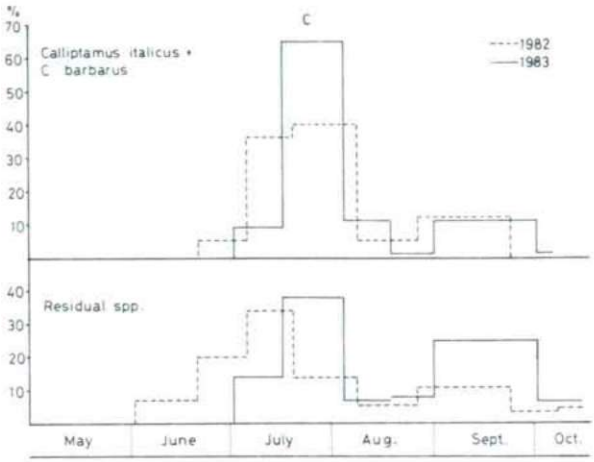


Fig. 7.C) Seasonal distribution of imagos of grasshopper populations.

We analysed the joint populations of *Calliptamus italicus* and *C. barbarus* because of the low number of individuals (in the examination period their abundance really decreased, and we can suppose that this collecting method is less adequate for them). Likewise, because of the low individual number, we joined the residual populations (populations regularly with low density) as a „residual" group, and evaluated their common movement. As it could be expected, we could not detect directionality in case of the two later groups, though the rate of their individual turnover directing to the experimental grassland patch exceeded that of emigration in both boundary zones, in both years, both in summer and in autumn aspect.

## Discussion

On the basis of studies dealing with habitats of similar type, we could suppose that the herbivore communities living on our experimental field have larger species set than those living on the pasture. This hypothesis was based on the properties of the habitat, such as larger diversity of microhabitats, larger phytomass (ANDRZEJEWSKA and GYLLENBERG, 1980; NAGEL, 1979), more comfortable microclimate (MÜLLER, 1980; MYERS, 1980), differences in the architecture of vegetation (LAWTON and SCHRÖDER, 1978; LAWTON, 1983; STINSON and BROWN, 1983), and presence of more, potential host plant species (MURDOCH et al., 1972; SOUTHWOOD et al., 1979).

Above hypothesis is authentic in the case of *Auchenorrhyncha* communities for the fauna of pasture parts farther from the boundary zone (GYÖRFFY unpublished data), but regarding the boundary zone the differences are not significant. In this zone the structure of joining vegetations is much more similar, than at the forest side

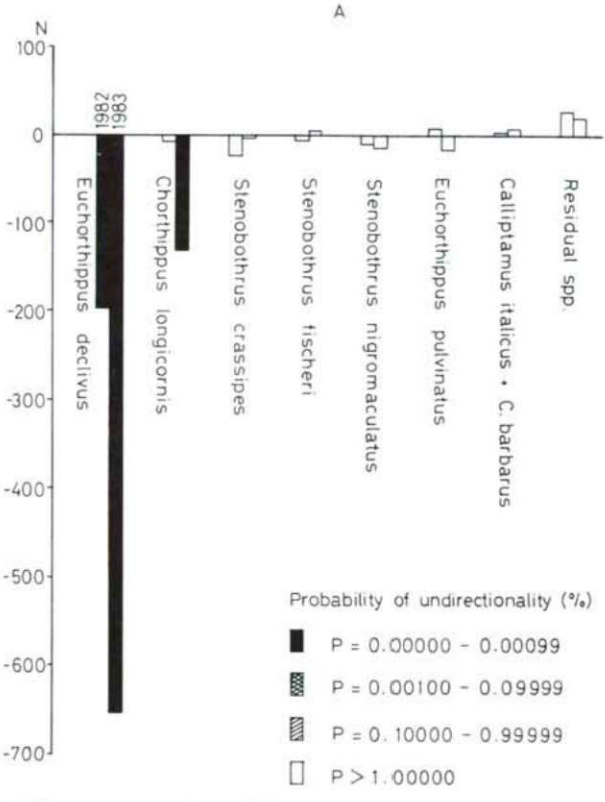


Fig. 8.A) Differences of numbers of „immigrant" and „emigrant" individuals of grasshopper populations at forest side, from summed data.

where the differences in species number are more considerable (cf. JAGOMÄGI et al., 1988). Shading effect of the forest also can be regarded at later site. Because of this the differences in the species number of *Auchenorrhyncha* communities, mobility of which is relatively lower, are important, while the species number of *Acridoidea* communities of larger mobility is the same everywhere.

Previous data also predicted that the probability of immigration is larger from the pasture to the experimental area. Active and directed movements can be increased by attractive effect of larger amount of phytomass (ANDRZEJEWSKA, 1971), by effect of quality of habitat to movement activity CLARIDGE et al., 1977; DENNO, 1985; THOMAS and SINGER, 1987), by small size of sampling area (GARBARCZYK, 1987), as well as by property of more varied architecture decreasing the wind effect (LEWIS, 1969).

This inrush expected from direction of pasture was experienced in both communities. In the case of *Auchenorrhyncha* the attractive effect of the sampling area increased mainly in the summer months in accordance with microclimate.

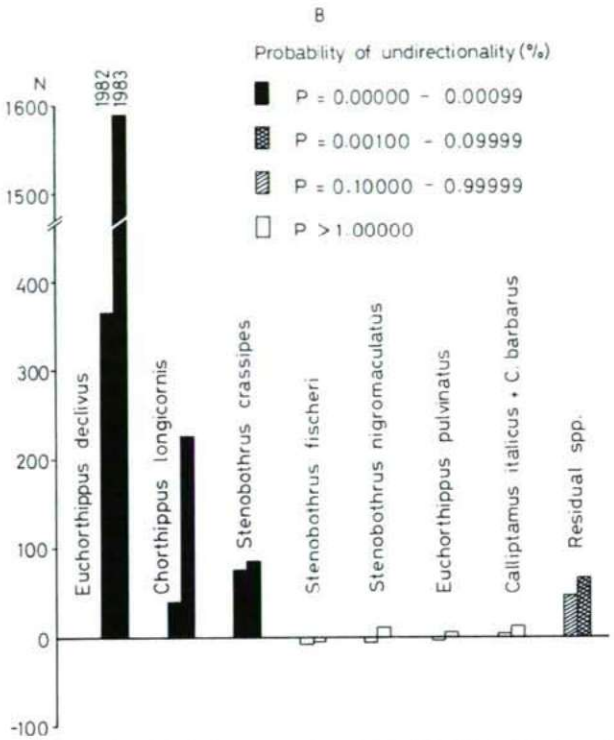


Fig. 8.B) Differences of numbers of „immigrant" and „emigrant" individuals of grasshopper populations at pasture side, from summed data.

Community of ungrazed area shared in species supply for the pasture in spring and autumn period, and ensured the intering of some populations arriving from the pasture in autumn, respectively.

The pasture gives a continuous supply for the sampling area considering the *Acridoidea* community.

On the basis of 17 examined *Auchenorrhyncha* populations we did not find such consistent trends appearing in both years, as was found at grasshoppers. Causes of this may be the less mobility and, connected with this, the coarse—grained behaviour (GALLÉ et al., 1985), the greater claim for host plants, the larger sensitivity to microclimate (and macroclimate), and in many case preferring the dormancy to migration.

As a result of their coarse—grained behaviour certain populations were of different abundance in the neighbourhood of some traps (e. g. *Gravesteiniella boldi*, *Agallia sinuata*, *Eupelix cuspidata*, *Hecalus glaucescens*, *Macustus grisescens*, *Falcotoya minuscula*) in spite of the fact, that we tried to place the traps in similar habitats. Because of this the differences in probability of directionality calculated

for each trap were often large, sometimes with opposite trends, that vitiated the value of significance.

More intense and significant directed movements are characteristic for populations of large density in grasshopper communities. KAUFMANN (1965) reported a density dependent, tough larval mass migration, and pointed out ordinal relation between density and speed of migration. No doubt that in our case the density effect has another sense, and it means not mass migration but increased frequency of directed movement pattern deriving from the large individual number. We can suppose from the significant undirectionality of relatively low density populations, that ecological conditions of the area are favourable for them, there is no stress to cause movements, since they segregate seasonally, their density is low, so there is no competition. Movement of „residual species" group supports this hypothesis, since it reflects to attractive and retaining effect of the area from both directions.

It is easy to understand, that in this experiment movement types of grasshoppers are in correlation with fine—grained projection of environmental heteromorphy (GALLÉ et al., 1985; SZŐNYI and KINCSEK, 1986), but we can not neglect that the populations are different in the preference of vegetational patches. ANDERSON (1964) studied the patch selection of grasshoppers, and determined its causes in correlation between taxonomic composition of vegetation and feeding type of grasshoppers. His final conclusion was that distribution of grasshoppers is nonrandom. Many case studies (e. g. FARROW, 1982; JOERN, 1983) support, that movement pattern of several grasshopper communities is very different, consequently large differences have to be supposed in their microhabitat selection.

## Aknowledgement

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